



National Institute of Standards & Technology

Certificate

Standard Reference Material[®] 1001

X-ray Film Step Tablet

This Standard Reference Material (SRM) is intended for use in the calibration of optical densitometers and similar equipment used in the photographic, graphic arts, and X-ray fields. SRM 1001 is a double emulsion X-ray film step tablet 25.4 cm (10 in) long by 3.5 cm (1.375 in) wide. The tablet has 17 steps 1.3 cm (0.5 in) wide perpendicular to the long edge of the film with certified transmission densities ranging from less than 0.200 to greater than 4.000. The serial number is located at one end of the step tablet.

Determination of Certified Transmission Density: The transmission density of each step of the tablet was measured using the NIST Diffuse Transmittance Densitometer [1]. The instrument and measurements conform to the conditions specified for ISO Standard Diffuse Visual Transmission Density, $D_T(90^\circ \text{ Opal}; S_H; \leq 10^\circ; V_T)$ [2,3]. The certified transmission densities listed in Table 2 were measured on a 3 mm diameter circle at the center of each step, and apply only to that area. When measured, the side of the tablet with the serial number was in contact with the diffuser of the densitometer.

Expiration of Certification: The certification of this SRM is deemed to be valid, within the uncertainties specified, for a period of three years from the calibration date given in Table 2, provided the SRM is stored and handled in accordance with the "Instructions for Use" and "Storage and Handling" sections of this certificate. However, certification will be nullified if the SRM is damaged or contaminated. Registration (see attached sheet) will facilitate notification.

Discussion of Uncertainties: Uncertainties were calculated according to the procedures outlined in reference 4. Measured (Type A) uncertainties were assumed to be Gaussian-distributed, and were calculated from the standard deviations. Estimated or inferred (Type B) uncertainties were also assumed to be Gaussian-distributed, and were calculated from the measurement equation. The uncertainties were combined by adding their variances in quadrature. Table 1 is a list of all identifiable sources of uncertainty. The measured standard deviations are listed in (a), the inferred standard deviations are listed in (b).

Source¹: Film step tablets were produced by GE Inspection Technologies, AGFA division, Goose Creek, SC.

The technical direction and physical measurements leading to certification were provided by E.A. Early with assistance from C.L. Cromer, D. Dummer, T.R. O'Brian, X. Xiong, and R.D. Saunders of the NIST Optical Technology Division and P.F. Wychorski of the Eastman Kodak Co.

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See Certificate Revision History on Page 3

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¹Certain commercial equipment, instruments, or materials are identified in this certificate in order to specify adequately the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

The support aspects involved in the issuance of this SRM were coordinated through the NIST Standard Reference Materials Program by C.S. Davis of the NIST Measurement Services Division.

INSTRUCTIONS FOR USE

Remove the film from its protective sleeve and place the center of a step on the diffuser of the densitometer to be calibrated with the side of the step tablet with the serial number in contact with the diffuser. Calibrate the densitometer using the transmission density of that step, and repeat this procedure with other steps of the step tablet.

Storage and Handling: The densities of this X-ray film step tablet may change with time. To minimize such changes, the film should be stored in a cool, dry place where it will not be exposed to light or other radiant energy or to chemical fumes, or to dust in the air. Scratches, abrasion marks, or foreign matter on the film can change the density. Fingerprints are a common source of contamination. Fingerprints on the film surfaces can be avoided by handling the step tablet only by the edges and by wearing clean cloth gloves available from photographic film dealers for this purpose. Any attempt to clean a film step tablet, other than to remove dust with a soft camel-hair brush, is not recommended as it is likely to alter the certified values.

Table 1. Tabulation of Uncertainties	
Source of Uncertainty	Uncertainty in Transmission Density
(a) Measured (Type A) Uncertainties	
Source Stability	± 0.001
Signal Noise	± 0.001
Amplifier Gain	$\ll 0.001$
Detector Linearity	± 0.001
Step Uniformity	± 0.001
(b) Inferred (Type B) Uncertainties	
Voltmeter Accuracy	$\ll 0.001$
Diffusion Coefficient	< 0.001
Opal Reflectance	< 0.001
Spectral Product	< 0.001
Combined Uncertainty (1σ)	± 0.002
Expanded Uncertainty (3σ)	± 0.006

REFERENCES

- [1] Early, E.A.; O'Brian, T.R.; Saunders, R.D.; Parr, A.C.; *Standard Reference Materials: Film Step Tablet Standards of Diffuse Visual Transmission Density – SRM 1001 and SRM 1008*; Natl. Inst. Stand. Technol. Spec. Publ. 260-135, U.S. Government Printing Office: Washington, DC (1998).
- [2] ISO 5-2: 2001, Photography - Density Measurements - Part 2: Geometric Conditions for Transmission Density; *International Organization for Standardization*: Geneva, Switzerland (2001).
- [3] ISO 5-3: 1995, Photography - Density Measurements - Part 3: Spectral Conditions; *International Organization for Standardization*: Geneva, Switzerland (1995).
- [4] ISO; *Guide to the Expression of Uncertainty in Measurement*; ISBN 92-67-10188-9, 1st ed. ISO, Geneva, Switzerland (1993); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297, U.S. Government Printing Office: Washington, DC (1994).

<p>Certificate Revision History: 20 May 2004 (This technical revision reports an extension of the certification period.); 14 October 1997 (Original certificate date).</p>

Users of this SRM should ensure that the certificate in their possession is current. This can be accomplished by contacting the SRM Program at: telephone (301) 975-6776; fax (301) 926-4751; email srminfo@nist.gov; or via the Internet at <http://www.nist.gov/srm>.

APPENDIX

Table 2. Transmission Densities of SRM 1001	
Serial No.: 0401001	Calibration Date: 1 October 2004
Step Number	Transmission Density^{a)}
1	0.177
2	0.243
3	0.495
4	0.743
5	0.993
6	1.239
7	1.493
8	1.739
9	1.995
10	2.240
11	2.490
12	2.755
13	3.005
14	3.230
15	3.502
16	3.712
17	4.046

^a Expanded uncertainty ($k = 3$) of the transmission density of each step is ± 0.006 (see Table 1).